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Dr. John Barrett

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Resource management

Component ecological footprint: developing sustainable scenarios

John Barrett

The component ecological footprint is presented and its value as a regional planning tool is demonstrated. The component ecological footprint of waste, transport, energy, water, bio-resources is calculated for Guernsey (Channel Islands). This tool also has the ability to be used to develop scenarios for a sustainable future. A detailed scenario for passenger transport on Guernsey is presented demonstrating that sustainability can only be achieved through intelligent rationalisation of means and prudent moderation of ends. In conclusion, the ecological footprint offers new insights into regional sustainability and what a sustainable society might look like. It is one of the few tools that attempts integrated resource accounting.

Keywords: sustainable development; regional planning; Guernsey

Dr John Barrett is at the Stockholm Environment Institute at York in the Department of Biology, Box 373, University of York, York, YO10 5YW, Tel: +44 1904 432893; Email: jrb8@york.ac.uk.

THE AIM OF SUSTAINABLE development is to achieve a decent quality of life for everyone within the carrying capacity of ecosystems. To understand the quantity of resources available to achieve this goal is essential. In simple terms, it is important to compare how much we use, with nature's supply. Tools are required to help guide humanity in a sustainable direction.

In the past, the approach of environmental policy has been towards the reduction in pollution levels and achieving safe standards for emissions (considering environmental and human health consequences). Increasing levels of consumption were, and still are, partly ignored. Also, the issue of justice acquires a different, and probably more fundamental, relevance to the environmental crisis (Sachs, 1999). This is defined in terms of excessive resource use. There is a need to concentrate on the issues of consumption and develop meaningful tools in providing a more comprehensive understanding of the consequences.

Component ecological footprint approach

The ecological footprint has grown in popularity since its co-inventors, Wackernagel and Rees, published *Our Ecological Footprint* in 1996.¹ The ecological footprint represents the national capital requirements of a defined population in terms of the corresponding biologically productive areas (Wackernagel *et al*, 1999). This includes the land required to provide the defined population with all its food and materials as well as absorb all its waste (particularly carbon dioxide (CO₂) emissions).

Ecological footprint analysis has been applied to various levels, from the global scale (Wackernagel *et*

al, 1997; 2000) right down to the household level (Simmons and Chambers, 1998; Chambers *et al*, 2000). In this study, the component ecological footprint of Guernsey has been calculated and its use as a tool for decision-making explored. This has been done by considering the ecological footprint of passenger travel, looking at time-series data and the development of scenarios.

The component-based approach, first documented by Simmons and Chambers (1998) and then Simmons *et al* (2000) is a different approach to ecological footprinting. Instead of considering the consumption of raw materials, it considers the effect of transport, energy, water and waste. It has a more simplistic and educative structure with more significance to the regional level. This is mainly because it is built around activities with which people can resonate and in which they participate (that is, we all produce waste and consume electricity).

Simmons and Chambers (1998) calculated the first series of algorithms capable of converting resource use to land-area equivalence, entitled the 'Eco-Index MethodologyTM'² (Chambers *et al*, 2000). Since then, the Stockholm Environment Institute has adopted their pioneering approach.

In the component-based model, the ecological footprint values for certain activities are pre-calculated using data appropriate to the region under consideration (Simmons *et al*, 2000). Within Wackernagel's approach (known as the compound ecological footprint) six major land types of productive space are used: fossil-energy land, arable land, pasture, forest, built land, and sea space. The compound approach considers the human demand on each of those land types for a given population, wherever that land may be. The component approach retains the original philosophy behind footprinting but has converted these into activities.

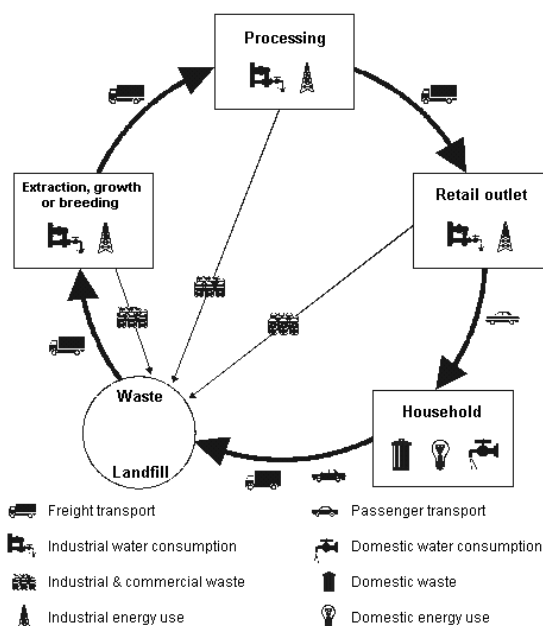


Figure 1. Model of the component footprint approach

Life cycle approach to footprinting

What the component model of footprinting is attempting to do is capture all human consumption for a particular given population and translate this into a land-equivalent. This can be seen in Figure 1, which provides an understanding of what can be calculated.

The model starts with the extraction, growth or breeding of an animal or material for human consumption. Both energy and water use are associated with this procedure. Freight transport is then required to move the produce to the factory for processing. At this stage, there is a large demand on industrial energy and freight transport to bring the many different products to the factory.

An excellent example of this is Boge's 'strawberry yoghurt pot' (Boge, 1995). The yoghurt and its ingredients and the materials used for the glass cup made journeys totalling 3,500 km. For example, the strawberries came from Poland to be processed in Germany, the corn/wheat starch came from Amsterdam, via Koln and then finally to Stuttgart and the aluminium sheeting came from Australia, via Norway, then Neuburg (southern Germany) before reaching Stuttgart (von Weizsacker *et al*, 1998).

Boge's calculations of the strawberry yoghurt not only demonstrated the substantial impact of freight transport but also the difficulty in collecting data like this. It is near impossible to find this much data for every product. The component footprint does provide part of the answer. It can calculate both freight transport (air, sea or road) and industrial energy use.

After more freight transport is used to deliver the final product to the retail outlet the footprint now attempts to include all the domestic impacts. These include passenger transport (car, bus, train and air) as well as domestic energy consumption and water use. After the product has been brought into the domestic environment it is disposed of (often packaging) and will leave as waste.

At this stage, the footprint can distinguish between different final disposal methods. If the item is disposed of by landfill, the embodied energy in that item is lost, therefore it has a footprint of the embodied energy of the item. If the item is recycled, the embodied energy is saved, so the footprint is merely the energy required to recycle the product.

The advantage of using the ecological footprint to understand human appropriation is its ability to make comparisons. It is possible to compare the emissions from transporting a particular good with the energy requirements of the product on the same scale (that is, hectares). It is also possible to compare the impact of domestic waste production with passenger travel.

Ecological footprint of Guernsey

Guernsey, one of the Channel Islands, was used as a case study to test the component ecological footprint. Located a few miles off Mont St Michel in Normandy,

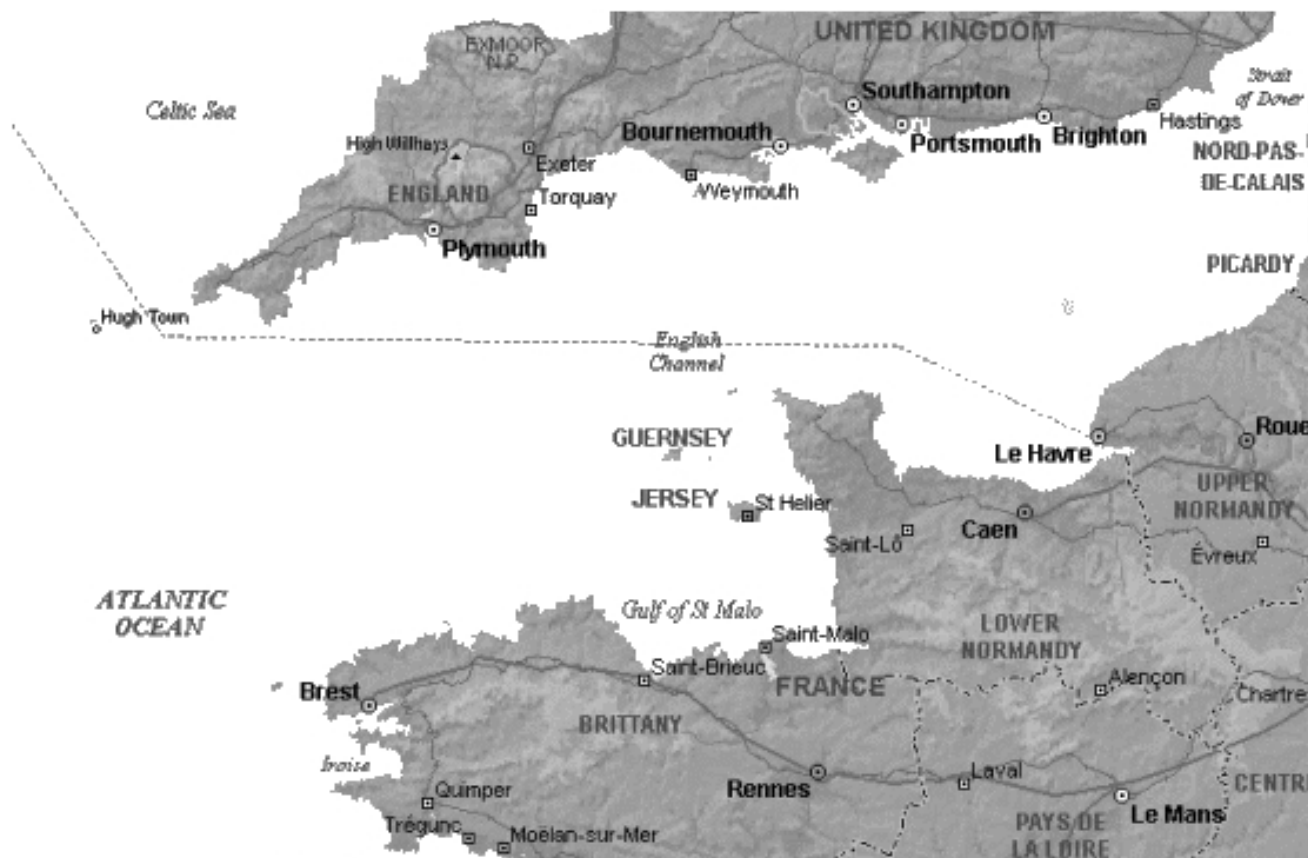


Figure 2. The Channel Islands, in relation to the UK and France

Source: Microsoft (2000)

France, the Channel Islands are comprised of the major islands of Jersey and Guernsey, and the smaller ones of Alderney, Sark, Herm, Jethou and Brecqhou (see Figure 2).

Guernsey is the second largest of these islands being 63.1 square kilometres in size. For a small island, Guernsey has a relatively high population of 60,000 residents. This can increase to 80,000 during the tourist season. Guernsey also has its own airport, harbour, telecommunications service, postal service and most significantly, its own parliament.

These factors provided a unique opportunity to study what is almost a mini-country, as it has its own political system, its own infrastructure (such as an airport, harbour and telecommunications company) and is a rich and prosperous island (an excellent opportunity for considering the impact of consumption).

Footprinting passenger transport

The explanation of the calculation procedure behind the ecological footprint of car travel provides an understanding of all the calculations involved with the other components (such as waste, water and energy). All the figures are based on one fact: the land area required to absorb the carbon dioxide produced by that particular activity. At present, the current carbon sequestration rate is estimated to be 100GJ (gigajoules) of fossil fuel burnt can be absorbed by 1 hectare of

forest.³ This equates to 1.42 tonnes of carbon dioxide sequestered by 1 hectare of forest in one year (Wackernagel and Rees, 1996).

An alternative method would be to consider the land required to supply the same amount of fuel using only that produced from biomass. Both methods produce similar results, with the carbon sequestration rate providing a slightly more conservative estimate. Adopting this approach does not mean that carbon sequestration is seen as the only solution to excessive emissions of carbon dioxide. Rather, it provides a land-based analogue of overshoot, since there is not enough land to provide humanity with all the necessary resources and to support critical life-support functions (such as the carbon balance).

To calculate the impact of car travel, data about fuel consumption, energy requirements of manufacturing

Guernsey gives a unique opportunity to study a 'mini-country', as it has its own political system, its own infrastructure (airport, harbour etc) and is a rich and prosperous island (excellent for considering the impact of consumption)

Table 1. Example analysis for the footprint of UK car travel per passenger-km

Component	Additional information	CO ₂ emissions	Built-upon land	Footprint
Petrol ^a		0.201 kg/km		0.00003932 ha/car km
Maintenance and manufacture ^b		0.091 kg/km		0.00001769 ha/car km
Road space ^c			3,047,145 ha	
Car road shared	86%			
Car kms (000's) ^e	6,160,000,000			
Car occupancy ^f	1.6 persons			
CO ₂ sequestration rate (CO ₂ /ha)	0.0001954 kg			
Footprint		0.00000004 ha/car km	0.0000364 ha/passenger-km	

Source: Updated from Simmons *et al* (2000)

^a London Research Council (2000)

^b Wackernagel and Rees (1996)

^c DETR (1999a) with an estimated average road width of 8.2m

^d DETR (1999a, page 39)

^e BRF (1999)

^f DETR (1999b, Figure 5.2)

and maintenance, land area occupied by roads in the UK and the distance travelled is collected. By following the calculation in Table 1, an average ecological footprint estimate is derived for a single passenger kilometre. This can then be used to calculate the impact of vehicle use at the individual, organisational or regional level as required (Simmons *et al*, 2000).

The UK Emission Factors Database (2000) provides detailed information of the carbon dioxide emission per km from a range of different vehicles, taking into account the speed of the vehicle and the type of road on which the vehicle is travelling. In the case of Guernsey, the 'urban' figure has been employed, because the speed limit on the island is 35 miles per hour (mph).

Table 2. Ecological footprint of various forms of travel

Transport type ^b	Footprint (ha/per year)	Assumptions
Car	0.0000364 ha/passenger-km	- Average petrol car fuel consumption - Road space & average car occupancy - Embodied energy
Bus	0.0000293 ha/passenger-km	- Carbon dioxide emissions from fuel - Carbon dioxide emissions from maintenance and manufacture - Apportioned road space
Airb	0.0000735 ha/passenger-km	- Based on data from UK Domestic Flight - Energy land - Degraded land

Notes: ^a The ecological footprint of train travel has also been calculated. However, this is not relevant for Guernsey, as there is no train service. The ecological footprint of motorcycle travel has also been calculated. However, no data was available at the time of this report

^b The figure for air travel has been provided by Best Foot Forward and has not been re-calculated like the figures for bus and car travel

Both the carbon dioxide emissions from petrol and the maintenance and manufacture of the vehicle are converted into a footprint figure using the method explained earlier. The ecological footprint of car travel also includes road space occupied by cars. Cars are responsible for 86% of the total road space. This figure does not need to be converted into a footprint figure, as it is already a land type (built land). Finally, the whole figure is converted into passenger-km by considering the average occupancy of a car (1.6 persons).

While this calculation procedure for the ecological footprint of a car passenger-km may only point to reducing the distance travelled in cars to reduce the ecological footprint, this is not necessarily the case. The actual algorithm will change over time, representing increases in the efficiency of cars, therefore producing less carbon emissions. An increase in car occupancy and even the speed with which the car travels also change the algorithm. A number of examples have been given below to demonstrate this point.

The car travel footprint has been placed into a simple computer program, where it is easy to develop scenarios. For example, in 2005 what will the ecological footprint of passenger transport be, taking into account the inevitable increase in fuel efficiency, an increase in car occupancy to two passengers per car and if drivers travel at the most energy efficient speed? The ecological footprint can easily predict this.

It can also incorporate other aspects such as what will the ecological footprint would be: if a more efficient and reliable bus service is introduced; or with the introduction of new train stations into urban areas? The model is flexible enough to deal with changes in behavioural patterns and technological advances while at the same time remaining transparent and not getting lost in specificity. It can combine as many aspects as is required to demonstrate the effect of passenger transport into the future.

Table 3. Component footprint analysis of Guernsey

Activity	Consumption items	Consumption	Footprint (ha)
Utilities	Electricity (Gwh) – domestic	591.20	76,143
	Gas (Gwh) – domestic	159.4	6,186
	Electricity – other (GWh)	764.23	98,428
	Gas – other (GWh)	0.16	6
	Water – household (m3)	12,500	124
Subtotal			180,887
Travel and freight	Sea freight (000's tonnes kms)	27,901	167
	Air freight (000's tonnes kms)	1,157.63	382
	Road freight (000's tonnes kms)	5085	371
	Travel by car (passenger 000's km/yr)	2,160,000	91,721
	Travel by bus (passenger 000's km/yr)	13,170	242
	Travel by air (passenger 000's km/yr)	46,656	2,204
Subtotal			94,487
Food, land and wood	Food (t)	60,000	89,052
	Built land (sq m)	10,286	10,286
	Wood products (m3 WRME)	70,015	45,944
Subtotal			145,282
Waste and materials	Recycled waste (t) – glass	7,106	3,627
	Recycled waste-paper and card (t)	8,366	11,629
	Recycled waste-metals (t)	5,500	1,210
	Recycled-other domestic (t)	644	380
	Waste – household (t)	19,000	48,015
	Waste – commercial (paper, metal etc.) (t)	12,500	23,484
	Waste – inert (brick, concrete etc) (t)	60,000	3,968
Subtotal			92,313
Population of Guernsey			60,000
Ecological footprint of Guernsey (hectares per year)			512,969
Hectares <i>per capita</i> per year			8.55

The same process can be undertaken for other forms of travel as well as energy, waste, water, housing stock and food. It is accepted that it will not be possible to understand all anthropogenic impacts but the methodology does include the most important impacts (Simmons and Chambers, 1998).

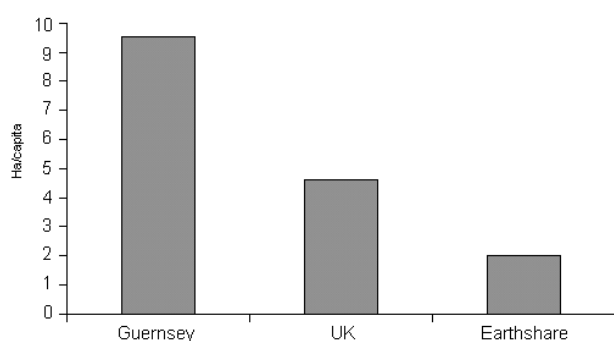
**Figure 3. Summary of per capita footprints**

Table 2 explains the other forms of transport within the calculation.

Results of component footprint of Guernsey

Table 3 presents the results of the component footprint of Guernsey. The first column is the activity in question, the second column displays the consumption data, while the final column has converted these figures into a footprint value.

Analysis of results

Guernsey's component ecological footprint is substantially higher than both the UK footprint and the global earthshare.⁴ This study estimates that the area of land required to support the population of Guernsey sustainably at current consumption rates and with prevailing technology to be 512,969 hectares of world

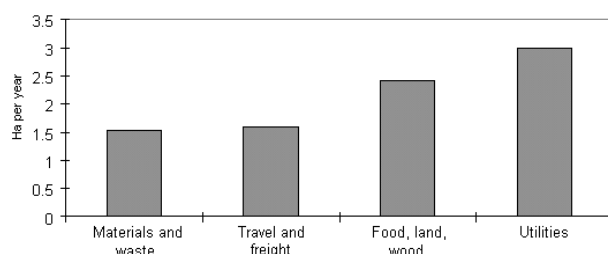


Figure 4. Footprints (per capita) by activity

Note: The category of utilities includes all the ecological footprint for energy and waste consumption

average productive land.

The average Guernsey footprint (8.55ha) is around 50% higher than the UK average (4.6ha) as shown in Figure 3.

A large number of individuals in Guernsey have a high dependence on their cars. A significant number of people live on Guernsey because of its tax status, meaning they are very wealthy individuals. Thus there is a multitude of expensive sports cars on the island, which is quite ironic as the maximum speed limit is 35 mph.

A methodological issue that may have affected the final figure is the accuracy of the Guernsey consumption data. With Guernsey being a small island, very accurate data for the ecological footprint was available. There was no need for the use of proxy data in the

calculation. With more data available, very often a higher ecological footprint is calculated. This may be responsible for some of the large differences between Guernsey and the UK.

A reduction in the ecological footprint cannot be accomplished merely by applying technocentric answers to the problem. While technology has a role to play in reducing the ecological footprint of Guernsey, changes on a larger scale are necessary. Reductions in resource consumption and waste minimisation are key tools to achieve an ecologically sustainable island.

What is particularly useful about the component ecological footprint of Guernsey is that it is possible to give a breakdown of areas that are responsible for a high footprint (see Figure 4). Moreover, it is now possible to see where the largest savings can be made.

An analysis by category of impact shows the highest to be utilities, followed by food, land and wood, transport and freight and then materials and waste. There are two main reasons for utilities being so high. First, by Guernsey producing all its electricity with an oil power station, the carbon releases are substantial. A gas power station, for example, produces roughly half the amount of carbon dioxide per kWh as an oil power station. Second, Guernsey has not made use of available renewable energy sources. The only positive way of viewing this is that there are many options still open to Guernsey to reduce carbon emissions.

High consumption of food and wood is indicative

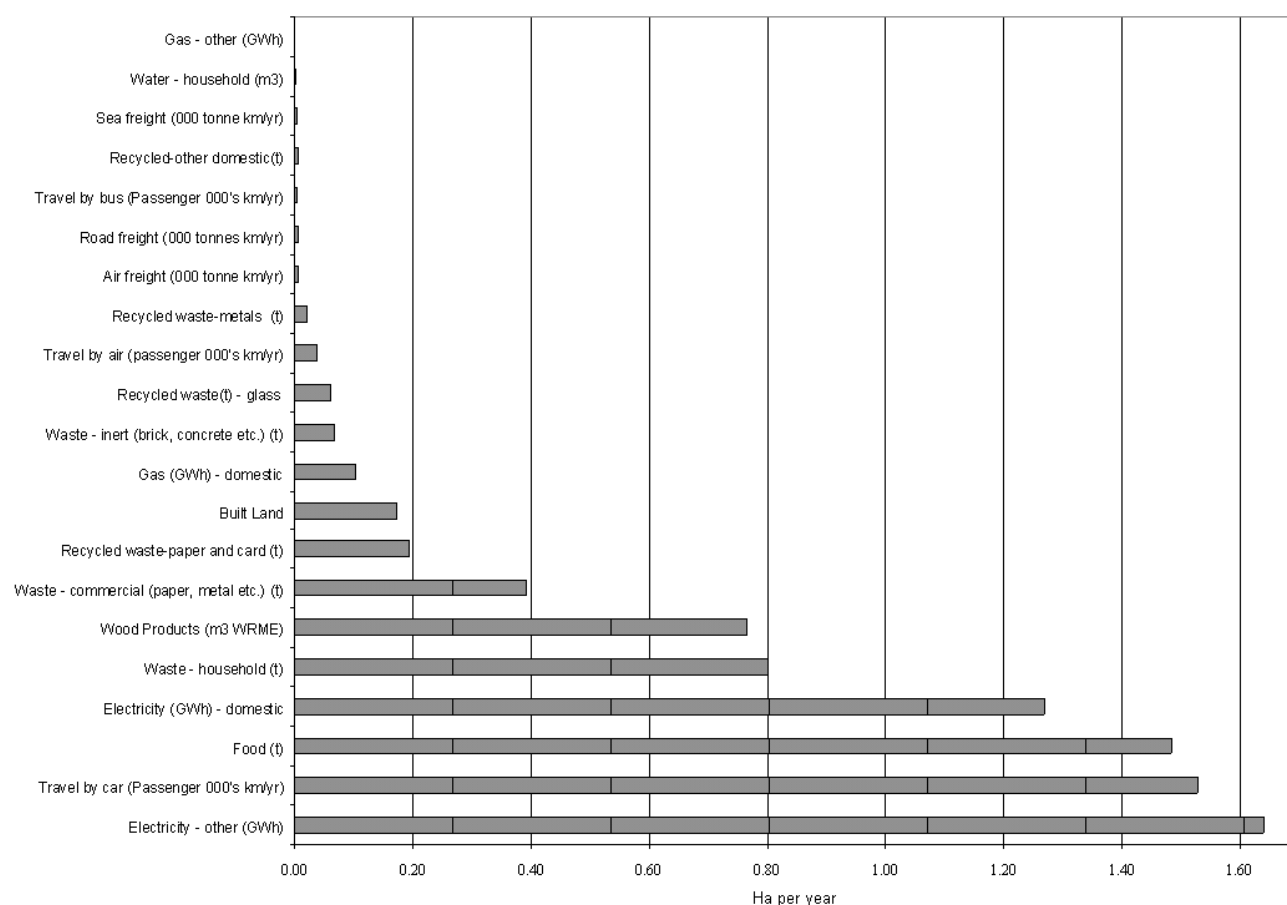


Figure 5. Guernsey footprint (ha/per capita) by component

of a rich community. Much of the freight transport and waste are based around that community's consumption, although in Figure 4 they are shown separately.

Figure 5 shows the distribution of impact by component, ordered in terms of the size of impact. It can be seen that the largest four are electricity (other), car travel, food and then electricity (domestic).

By gaining such detailed information and through the aggregation of the different components, scenarios can be generated in an attempt to understand the reductions that can be made with each component.

Passenger transport: a time-series analysis

Guernsey has seen a steady increase in both private and commercial motor vehicles registered on the island. There has also been an increase in the average distance travelled. Comprehensive data on both the numbers of vehicles and distance travelled have been obtained from the Guernsey Traffic Committee as far back as 1950.

In 1950, a total of 6,822 vehicles were registered in Guernsey, compared to 44,434 vehicles in 1996. It was estimated in 1950 that the average vehicle travelled 4,000 kms per year, compared to 8,800 kms per year in 1996. The main two reasons for this are concerned with the patterns of jobs within the island and an increase in leisure activities. In 1950, the Guernsey economy was not dominated by the finance industry. More localised economies such as agriculture, horticulture and manufacturing were in place so there was less need to travel than now. Nowadays, nearly all the

banks in Guernsey are in St Peter Port (the capital) and the majority of their staff use a car to get to work.

Figure 6 demonstrates a steady increase in the ecological footprint of road transport in Guernsey from 1950. In the 1980s, the footprint increased quite rapidly while there are signs that it was stabilising in the 1990s. This may be because of the recession; even though Guernsey was not affected by this as much as the UK. Only two years (1993 and 1994) showed a decrease in the ecological footprint from the previous year in a time period of 50 years.

Not one policy in Guernsey has been employed to decrease the ecological footprint of road transport. While many options have been available, such as the introduction of car parking fees, improved public transport and limiting car parking spaces in St Peter Port, none has been adopted. There has also been no mention of introducing car-sharing schemes for office workers in capital.

An obvious reason for the increase is a growth in population. Therefore, Figure 7 highlights the road transport footprint in *per capita* terms. While the number of vehicles on the island has increased, on a *per capita* level there were more cars travelling further in 1995 than in any other time in Guernsey's history. There are now more cars registered in Guernsey than there are people to drive them.

A clear sign of prosperity is high car ownership and this time-series analysis provides a warning to Guernsey as to what the potential increases in the ecological footprint road transport may be. The application of time-series data could help to establish targets in future policy objectives, similar to those set in global

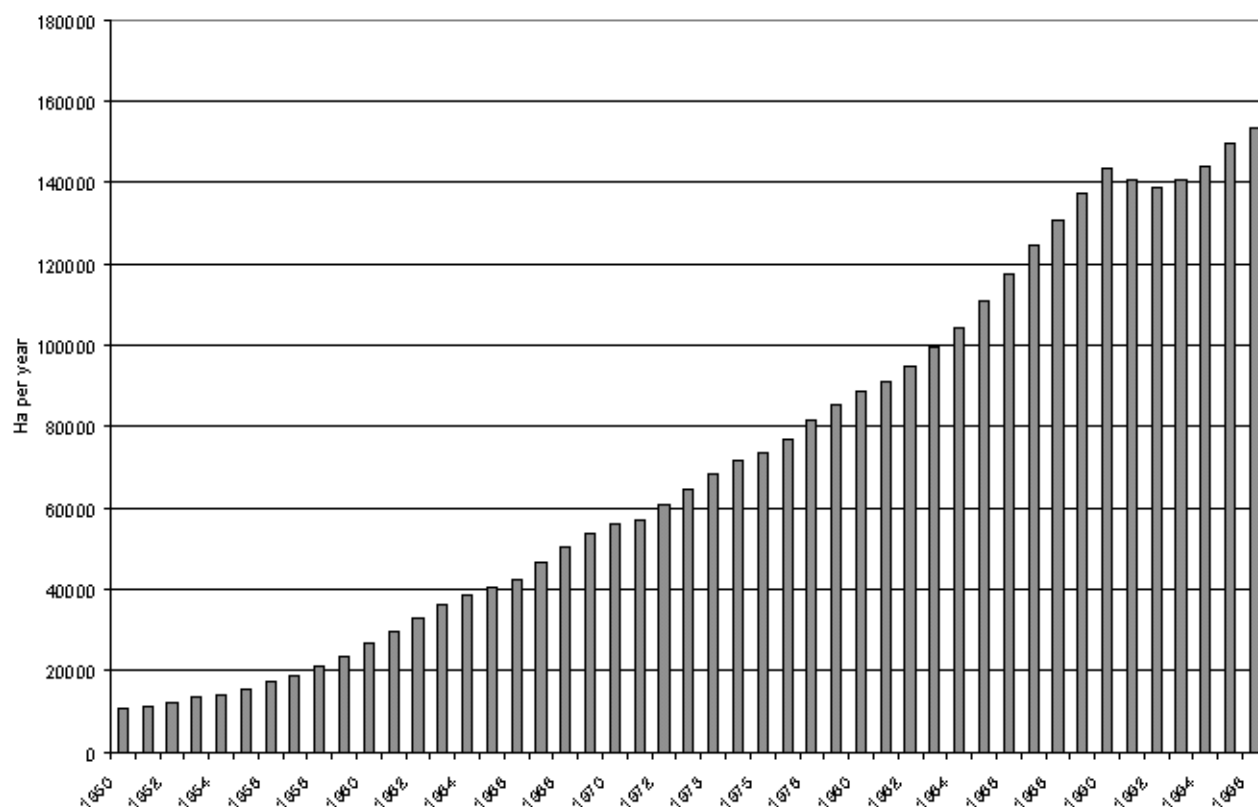


Figure 6. A time series analysis of road transport in Guernsey (1950–1996)

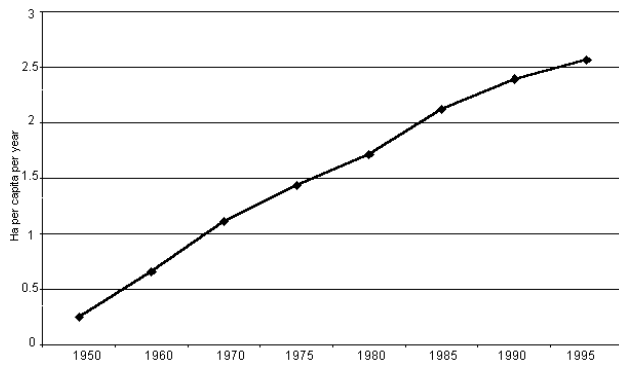


Figure 7. Per capita increase in ecological footprint of road transport in Guernsey (1950–1996)

carbon policy, that is, to reduce the ecological footprint of road transport to 1990 levels by 2005.

A sustainable model for Guernsey

To understand whether it is possible for Guernsey to live within its fair earthshare, a model has been proposed (under the four categories used in Figure 4). This is by no means a definitive model of how Guernsey can achieve sustainability, but more of an example of the potential reductions that can be highlighted through the eyes of the ecological footprint.

Figure 8 provides the current ecological footprint of Guernsey along with the sustainable model. It is assumed that the four categories (utilities, waste, bio-resources and transport) will remain the same. The sustainable model situation for Guernsey displays an equal reduction in these four categories.

The sustainable model exemplifies the need for a change in the metabolism of the island. The metabolism of Guernsey is the “flow of resources and products through the island for the benefit of urban populations” (Girardet, 1999). Natural ecosystems have an intrinsically circular metabolism, the output from one organism becoming the input for another.

For Guernsey, and many settlements of the developed world, the metabolism is linear. Materials and energy flow through the island for the benefit of one organism, without much concern about its origin, the

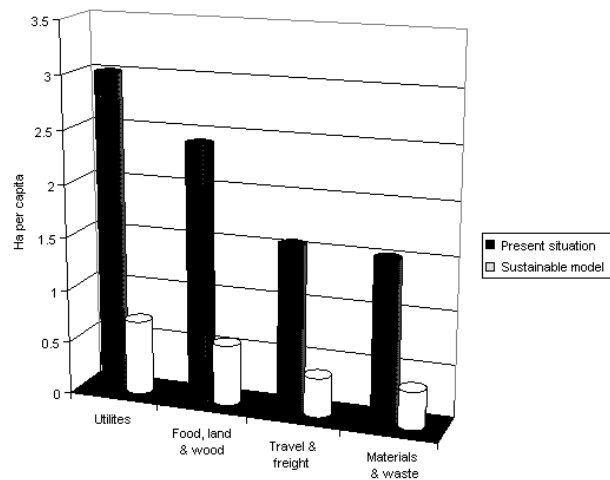


Figure 8. A comparison of the present situation and the sustainable model for Guernsey

destination of waste products or the energy requirements. There is very little connection between the outputs of the island and the inputs. The two models are presented in Figures 9 and 10 to provide a clearer understanding of the different metabolisms.

The linear metabolism of Guernsey corresponds to raw materials being extracted from nature, combined and processed into consumer goods and producing waste. In contrast, the circular metabolism is a cycle of energy and resources through a system, as opposed to a flow of raw materials. To reduce the ecological footprint of Guernsey, the application of ecological-system thinking needs to become prominent in the island’s agenda (Girardet, 1999).

When the decision is made to shift from a linear metabolism to a circular one, it opens up a whole spectrum of innovative ideas and concepts. New economic opportunities become available, which could help add diversity into the Guernsey employment market. With such a shift comes a shift in values. Waste is not seen as waste anymore, it is now a valuable resource. The local economy is considered to be an important element of the island as opposed to merely relying on imported raw materials.

An example of passenger travel is given below to

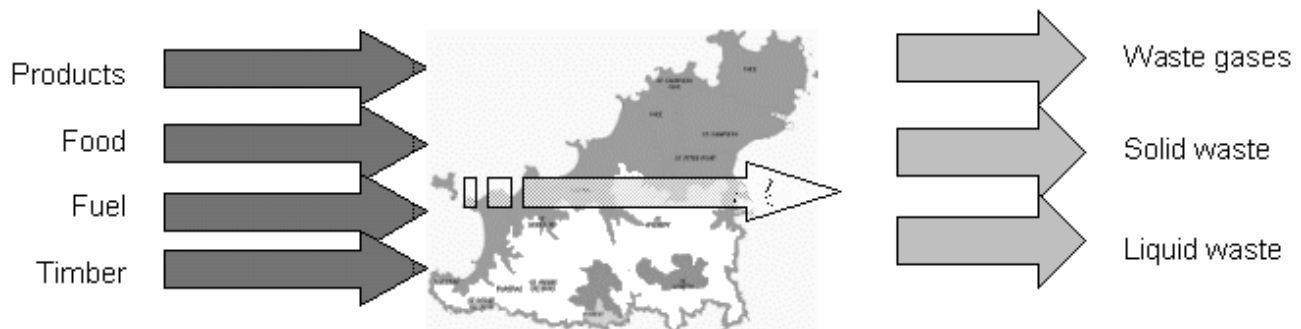


Figure 9. Linear metabolism of Guernsey

Source: Adapted from Girardet (1999, page 36)

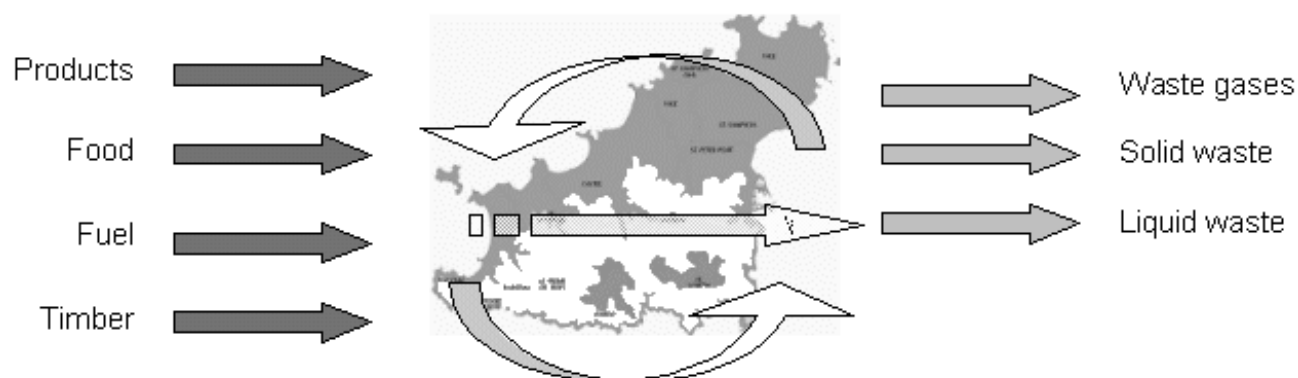


Figure 10. A circular metabolism for Guernsey

Source: Adapted from Girardet (1999, page 36)

show how the ecological footprint can help guide Guernsey from the unsustainable linear model to a circular metabolism by creating sustainable scenarios.

This scenario includes all forms of transport, with car travel having the most significant impact (the second highest impact of all the components, see Figure 5). The ecological footprint of the passenger transport in total demonstrates an extremely high reliance on the car for all activities. To understand the ecological footprint of passenger transport for different activities, UK Government statistics have been applied. This provides an insight into the effect of commuting, shopping and school trips (Table 4).

Changing the daily commute

To understand the change in transport behaviour and the subsequent reduction in the ecological footprint it is important to have some knowledge of the current modal split. Without a travel survey to provide an accurate estimate of the current modal split it is difficult to formulate a modal shift strategy with sufficient confidence to propose detailed courses of action. For the purpose of this scenario it is possible to make a reasoned assessment, based on the available information.⁵

Use of car with driver the only occupant	= 78%
Use of car with more than one occupant	= 7%
Walking to work	= 6%
Cycling to work	= 6%
Use of bus to travel to work	= 3%

In the linear metabolism raw materials are extracted from nature, combined and processed into consumer goods and produce waste: in contrast, the circular metabolism is a cycle of energy and resources through a system so that waste becomes a valuable resource

These figures represent the modal split for the daily commute into St Peter Port. Most of the commuters are employed within the finance industry (about 80%) while the other 20% are made up of the hotel industry, tourist industry and a small proportion of other industries. Therefore, it is reasonable to assume that most commuters will be arriving in St Peter Port between 08:00 and 08:45 and leaving between 17:00 and 17:45. This is reflected in the congestion of traffic arriving and leaving St Peter Port at these times.

This scenario is based on a three-year transport scheme to change the modal split. It is not possible to predict the exact percentage change in the modal split. However, it is suggested that, if implemented, a change in the modal shift of between 20% and 30% can be achieved. Details of the scheme are now given.

Car sharing

Car sharing is often one of the most successful areas of modal shifting, because it involves a less drastic change to the culture of car-borne travel behaviour. At present, it is estimated that only 7% of the commuters are car sharing and most of that is estimated to be between couples travelling to St Peter Port.

Table 4. Journey's per person per year by main mode and purpose combined with the corresponding ecological footprint of mode for Guernsey.

Purpose of trip	Percentage of journeys	Consumption (passenger/km)	Ecological footprint of journeys (ha)	Ecological footprint per capita
Commute ^a	28	604,800	25,681.99	0.428
School trips	19	410,400	17,426.99	0.290
Leisure ^b	16	345,600	14,675.36	0.245
Shopping	22	475,200	20,178.15	0.336
Social	15	324,000	13,758.15	0.229

Notes: ^a includes: personal business (8%); cause of work (3%); and commute (17%)

^b includes: eating and drinking (3%); entertainment (4%); holidays (1%); day trips (6%); and sport (2%)

Source: columns 1 and 2, DETR (1999); columns 3 to 5, author

Previous studies, conducted by Whitelegg (1998; 1999) indicate that 47% of the total commuters are prepared to consider car sharing, so there appears to be the scope for expanding it within Guernsey. Car sharing is perceived to work best when hours are fixed, a situation that does occur in St Peter Port in many of the offices.

Measures to improve the attractiveness of car sharing could increase its use, but the extent of this effect is difficult to judge. Existing low levels of sharing could indicate a high potential for further growth. The following calculation is the potential car share for the scenario.

Assumption 1: A shift of 47% of the single car drivers to car sharing meaning a 37% shift of the total commuter population. Therefore, the total commuter population involved within car sharing is 44%.

Assumption 2: The average occupancy for a shared car is 2.5 occupants.

Of commuters using a car, 78% travel with only the driver. Therefore, with a shift of 47% towards car sharing, this signifies a decrease in passenger/km travelled of 88,687.9 km reducing the commuter passenger/km to 383056.1 km. This represents a reduction of 14.66% in passenger/km for commuting.

The reduction in the ecological footprint for commuting is therefore 13,446.3 ha/per year, which on a *per capita* basis means an ecological footprint for passenger car transport of 1.3 ha/*per capita*, a reduction of 0.22 ha/*per capita*.

To help inaugurate a car-sharing scheme several incentives can be put in place:

1. Guaranteed ride home: this was introduced by Boots, to overcome the fear of the lift failing by guaranteeing a taxi ride home in such an event.
2. Car share advice scheme: this would provide commuters with all the necessary information on car sharing, including a computerised database to put people in touch with other commuters living in the same area.
3. Preferential parking facilities: car sharers can be allocated the best parking places closest to the offices, and be offered free parking where charging will be put in place.

Car parking

Levying a charge for workplace parking is a potential tool in encouraging modal shifts in travel behaviour, by increasing the cost of travel by car, thereby decreasing the car's financial attractiveness relative to other modes. At present in Guernsey, there are no car parking charges for any of the car parks. This has proved to be a controversial topic and there have been major objections to plans by the States Traffic Committee (STC) to introduce parking charges in the three main car parks in St Peter Port.

Because of the controversial nature of such charges, the STC commissioned a report on how much people would be willing to pay before shifting to another mode of transport, or car sharing. The results were that if a £2 per day parking charge was introduced, a 12% modal shift would occur (STC, 1996). Unfortunately, the study did not attempt to predict what this modal shift may be (cycling, bus or walking). However, this does offer an insight into the potential modal shift with the introduction of car-parking charges.

Taking the figure of a 12% modal shift, the reduction in the ecological footprint of passenger transport would be 11,007 ha/per year, which signifies a reduction of 0.18 ha/*per capita*.

Improved bus service

Guernsey's existing bus service is unpopular and often accused of being unreliable and infrequent. In an effort to reduce the ecological footprint of commuting, a bus service that caters for the busiest times is essential. At present there is no such system. Attempting to calculate what the reduction in car use may be with the introduction of a more popular bus service may be difficult. However, an assumption has been calculated based on passenger numbers.

Guernsey buses are small, only holding an average of 26 people. Therefore, if we assume the bus is half full for all its journeys, it has the ability to remove 16 cars from the road with one bus journey (assuming the average occupancy of a car is 1.6). Therefore, a 10% reduction in car passenger/kms only signifies an increase of 1.6% in bus passenger/kms.

What is most noticeable about Figure 11 is the substantial reduction in the ecological footprint with a modal shift from the car to the bus. If the assumption that a 10% modal shift towards buses can be achieved, the reduction in the ecological footprint is 0.15 ha/*per capita*.

School trips

In Guernsey, nearly 80% of all school trips are by car. This offers an opportunity to reduce the ecological footprint of the school run substantially with the introduction of 'walk to school schemes', school bus services, and cycle-friendly routes for school children. Only a small percentage of school children would not be able to benefit from one of these three schemes. There is no reason, other than apathy, why an integrated transport system could not accommodate all the schools.

Figure 12 introduces a scheme whereby each class from every school in Guernsey could understand the ecological footprint of travelling to school by car. It documents an example taken from one class in a school in Guernsey. The whole class of 18 pupils was asked to find out how far it was for them to travel to school each day and how they travelled. Figure 12 demonstrates how far each pupil would have travelled each year and the ecological footprint of the class.

In a very visual depiction of their journeys, Figure

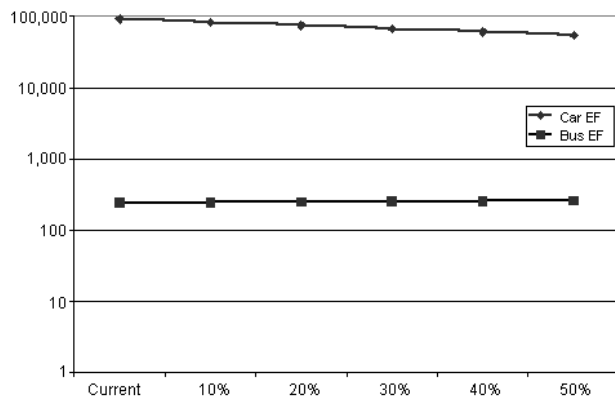


Figure 11. Subsequent increase in the ecological footprint of bus travel with a reduction in car use

Note: The scale is logarithmic to make it possible to see the increase in the ecological footprint of buses in comparison with the reduction in the ecological footprint of car travel

12 highlights that some pupils have travelled as far as the north of Scotland in one year. Figure 12 provides an educational tool by which each class can compare its ecological footprint for commuting to school and understand the importance and the methods by which to change this.

There can also be comparisons between schools, on a *per capita* basis, even a school competition for the

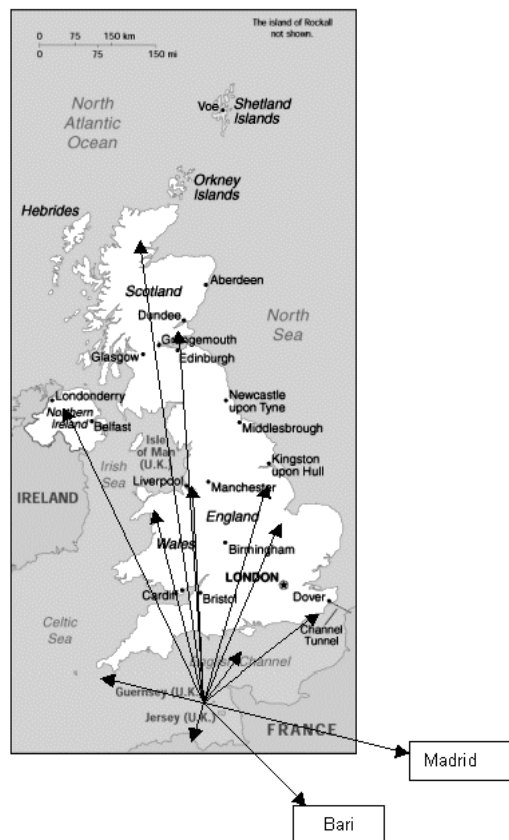


Figure 12. Equivalent distance travelled in one year by one class of 18 pupils

lowest footprint. With funding from the States of Guernsey made available to schools, there will be a greater emphasis on providing buses for school trips, encouraging the use of the bike and walking for pupils that live close to the school.

Figure 12 demonstrates that out of the whole class of 18 pupils only five walk to school, none use the bus or cycle and the rest travel by car. There is enormous scope for improvement.

Other possible car travel reduction schemes

Other schemes that could potentially reduce the ecological footprint of passenger transport are the introduction of cycle routes, more localised shops and working from home. These are all ideas that require further investigation. When the reduction in car use can be calculated for each these activities it is possible to establish the effect they could have on the ecological dimension of sustainability through the use of the ecological footprint.

Potential reduction in the passenger car footprint

The potential for reducing the ecological footprint of passenger transport in Guernsey is substantial. By applying some assumptions it is possible to estimate an overall reduction in the ecological footprint of passenger transport for Guernsey:

1. Change in commuter behaviour 0.22 ha/per capita
2. Introduction of parking charges 0.18 ha/per capita
3. Improved bus service 0.15 ha/per capita
4. A 50% behaviour change in school trips 0.15 ha/per capita
5. Introduction of other possible transport solutions 0.10 ha/per capita

Overall reduction in ecological footprint	0.8 ha/per capita
Equivalent ecological footprint of	48,000 hectares
Current ecological footprint of passenger transport	1.53 ha/per year
Future ecological footprint with introduction of sustainable transport scenario	0.73 ha/per capita

Although assumptions have been made to reach this final figure, the ecological footprint has offered an insight into the benefits of changing commuter patterns. The one caveat to this conclusion is that there is a degree of overlap in the target populations for the various modes. Therefore, the reduction in the ecological footprint could be lower than calculated.

Conclusions

As a sole indicator for sustainable development the ecological footprint is very limited as it fails to consider economic and social issues. Therefore, when

considering it as an indicator to guide policy it is only under the remit of environmental topics. Policy measures to reduce the ecological footprint of an area would support many initiatives and ideas already in place, such as changing material flows and consumption patterns to a more sustainable level and reducing carbon dioxide emissions through energy efficiency and the use of renewable energy.

The ecological footprint facilitates political decision-making as it offers a simple, transparent approach for comparing sustainability impacts of human activities. It presents an heuristic tool that builds on present knowledge and stimulates future-orientated thinking. Even though the ecological footprint is a scientifically based tool, it can deal with generalities rather than getting lost in specificity. It helps to sharpen the debate between conflicting assumptions and beliefs around such issues as ecological efficiency, growth management and impact assessment.

While poor countries are limited with regard to resources, the industrialised countries (Guernsey being an excellent example) are able to take more than their fair share of the Earth's resources. The ecological footprint graphically underscores global ecological constraints and provides a warning about the reliance on economic expansion. In fact, the ecological footprint's conceptualisation of the global ecological challenges, whilst linking them to local decision-making, is an aspect of the tool that is invaluable.

The evolution of the component approach to footprinting has demonstrated more clearly than the compound approach, the necessity for local and regional policies to adopt sustainable ideals. Through the component approach the ecological footprint concept can be taken a step further by linking these global constraints to local action. Its various applications to technology assessment, local and regional decision-making, national and international decision-making, inter- and intra-national social equity, and education and behavioural analysis provide venues for pertinent policy responses (Wackernagel, 1994).

Even though there remains much scope to improve the technical aspects of the component ecological footprint (particularly with regard to nuclear power, incineration and the transport of waste), the tool's potential to translate global ecological constraints down to the individual and institutional decisions is second to none.

Notes

1. This was not the first publication concerning the ecological footprint. Both Rees and Wackernagel have prior publications. However, this one raised the profile of the accounting tool.
2. The Eco-Index Methodology is a registered trademark of Best Foot Forward (an environmental consultancy in Oxford which pioneered the component approach. Visit its web site for further details on other publications concerning the ecological

footprint: <www.bestfootforward.com>.

3. In the ecological footprint, only one function can be attributed to a particular piece of land. In reality, land can provide a range of functions: forest can sequester carbon, supply biodiversity and recreation. This is an element of the ecological footprint that requires further attention.
4. Dividing the amount of bio-productive land on the Earth derives the average earthshare of the world's population, which, in 1998, was 2.21 hectares. The earthshare merely acts as a comparison between the different footprints of Guernsey and the UK. This paper does not necessarily assume that an egalitarian society is a realistic possibility.
5. The available information includes: information from participants within the focus group study, the number of car-parking spaces provided in St Peter Port (which are always full), discussions with staff at the States Traffic Committee and discussion with the transport officer for Friends of the Earth (Guernsey).

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